APPENDIX E

Land Crab Trace Element and Total DDT Statistical Analysis

This appendix presents a statistical analysis of the trace element and total DDT data for land crabs. To distinguish sampling areas that may be significantly different from each other, the means from all areas, including reference locations, were compared. Nonparametric Kruskal-Wallis tests were conducted, along with parametric ANOVA followed by multiple comparisons. Results from these tests were the same; for ease of presentation, only the results of the ANOVA tests are discussed below. Multifactor tests that evaluated the impact of sex and size were also performed, but these factors were insignificant in all tests. Those results are therefore not shown here.

In these calculations, the method detection limit for trace elements was used to represent values reported as non-detects. For total DDT only the detected compounds were summed, that is, non-detects were treated as zeros. Since nonparametric tests rely on ranks, and not absolute values, this method of accounting for non-detects tends to have marginal impact on the results. An alpha of 0.05 was applied for significant findings (a p value lower than this indicates a statistically significant difference exists among some sampling areas). The sampling areas were:

Area 1: Downgradient from SWMU 7
Area 2: Downgradient from AOCs J and R
Area 3: Laguna Kiani
Area 4: Laguna Kiani South
Area 5: Boca Quebrada
Area 6: Laguna Playa Grande
Area 7: Mosquito Bay
Area 8: Puerto Ferro
Area 9: Red Beach
Area 10: Blue Beach
Area 11: Bahia Tapon
Area 12: Live Impact Area (LIA)

Reference sampling locations were:

Area 13: Blue Horizon Reference
Area 14: Humacao Wildlife Reserve, Main Island Reference

The ANOVA table splits the variability observed in concentrations of each trace element into two components: a between-areas component and a within-areas component. The variability of these two components is then compared by calculating an *F-Ratio*, which is the ratio of the between/among-areas components. If the ratio is sufficiently large (i.e., there is much more variability between areas than within), then the probability (*P-Value*) that the mean concentrations at all areas are even is small. A *P-Value* less than 0.05 is associated with a 95%

confidence level and is generally considered significant. To determine which means are different from each other, a Multiple Range test was performed.

In the Multiple Range test, area means are ranked from lowest to greatest. Groups with means that cannot be distinguished from each other (i.e., homogeneous groups) are then identified using columns of X's. Within each column, the concentrations joined by X's form a group of means within which there are no statistically significant differences (using Fisher's Least Significant Difference procedure). With this approach, there is a 5% risk of calling any given pair of means different when they are not. Because the area means span a range, there are often columns of homogeneous groups that overlap other columns of similarly homogeneous groups.

Graphs are included to further illustrate differences between areas. In these graphs, areas are ordered across the graph, and the mean at each area is plotted showing its distance from the overall grand mean of concentrations (in blue). If an area mean is extremely different from the overall grand mean of all areas, that value may be different. Upper and lower decision limit lines (in red) are calculated and plotted such that pair-wise indications of differences have a 95% confidence level associated with them.

Additional information regarding apparent differences is noted as appropriate.

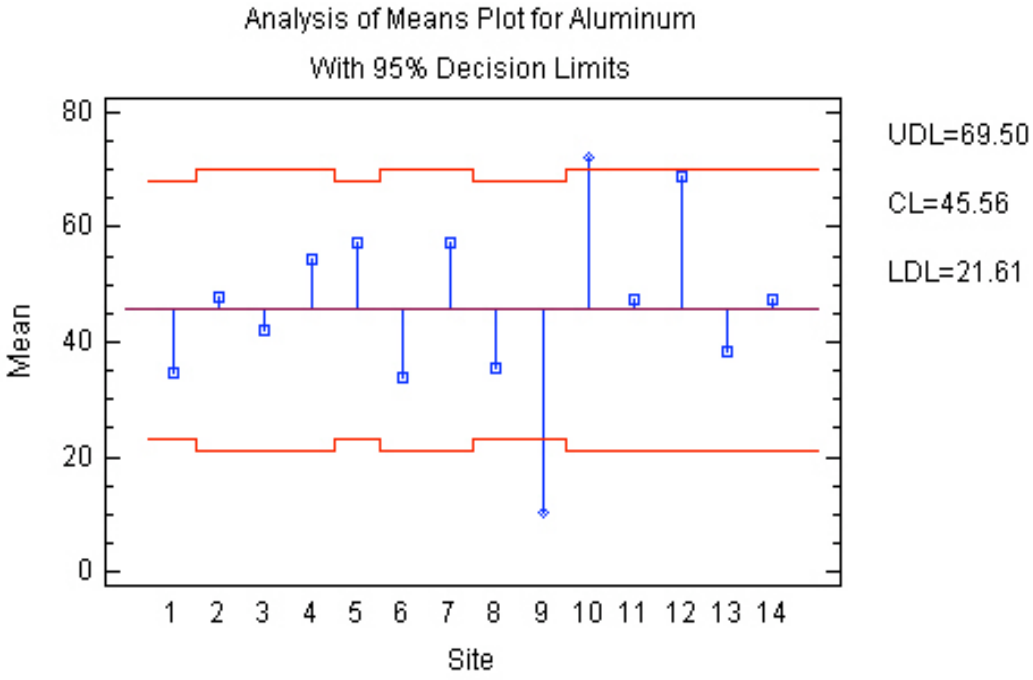
ANOVA Table for Aluminum by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	17943.7	13	1380.28	3.86	0.0002
Within groups	21467.2	60	357.786		
Total (Corr.)	39410.8	73			

Multiple Range Tests for Aluminum by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
9	6	10.3833	X
6	5	33.88	X
1	6	34.5667	X
8	6	35.3667	X
13	5	38.34	XX
3	5	42.0	XX
14	5	47.22	XXX
11	5	47.34	XXX
2	5	47.78	XXX
4	5	54.52	XXXX
7	5	57.18	XXXX
5	6	57.2833	XXX
12	5	68.88	XX
10	5	71.98	X



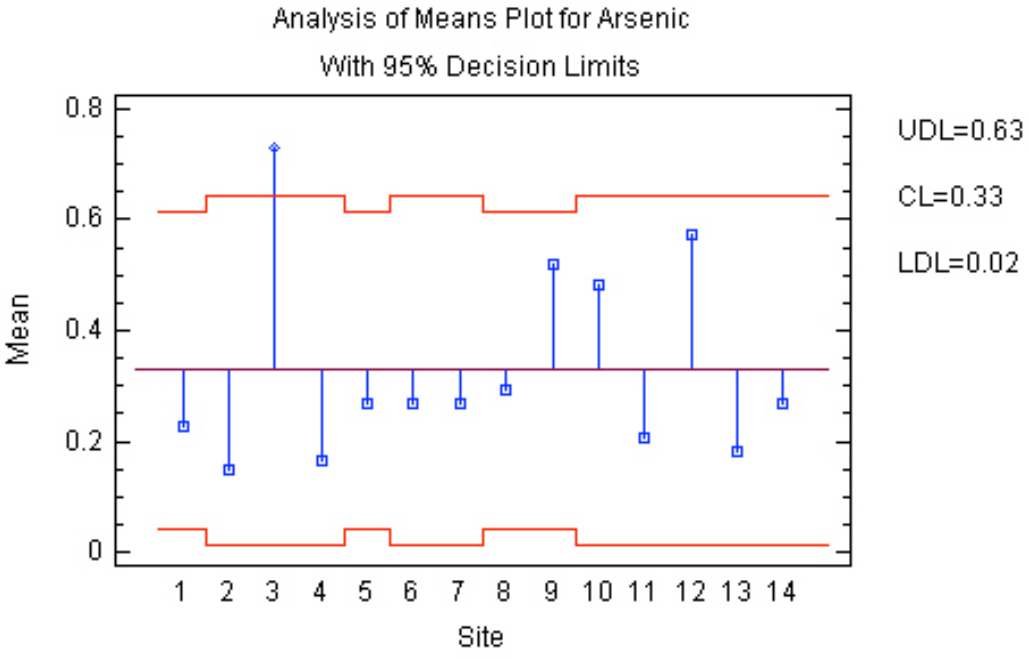
ANOVA Table for Arsenic by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	2.06444	13	0.158803	2.72	0.0044
Within groups	3.5037	60	0.058395		
Total (Corr.)	5.56814	73			

Multiple Range Tests for Arsenic by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
2	5	0.148	X
4	5	0.164	X
13	5	0.18	XX
11	5	0.208	XX
1	6	0.228333	XX
5	6	0.266667	XXX
7	5	0.268	XXX
6	5	0.268	XXX
14	5	0.268	XXX
8	6	0.291667	XXXX
10	5	0.482	XXXX
9	6	0.52	XXX
12	5	0.574	XX
3	5	0.728	X



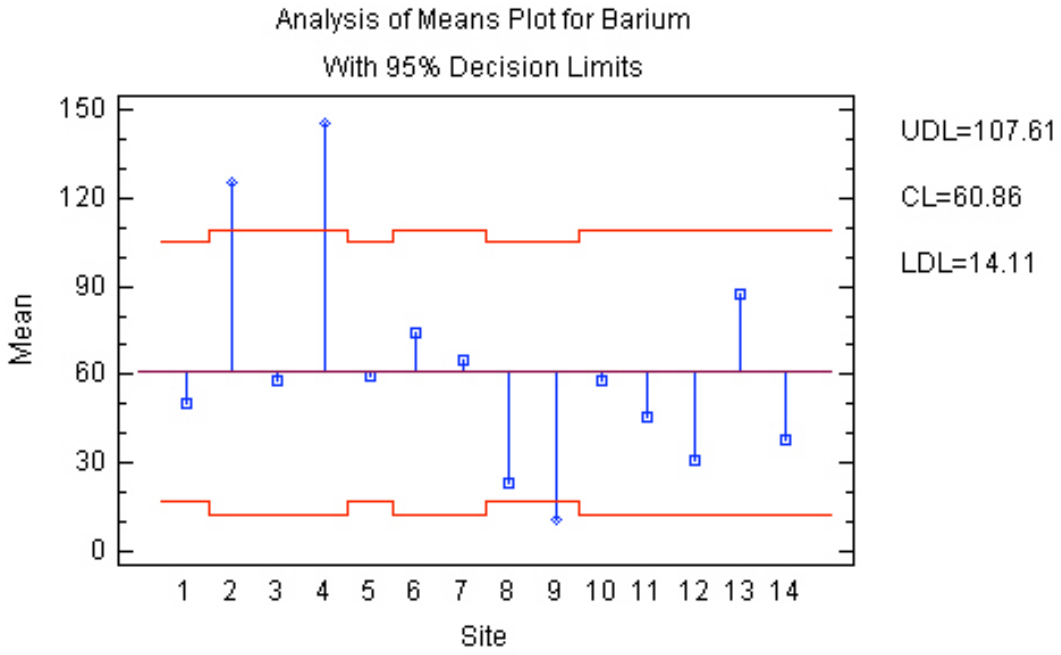
ANOVA Table for Barium by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	93482.9	13	7190.99	5.27	0.0000
Within groups	81836.1	60	1363.94		
Total (Corr.)	175319.	73			

Multiple Range Tests for Barium by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
9	6	10.5883	X
8	6	23.2	XX
12	5	31.2	XXX
14	5	37.62	XXX
11	5	45.7	XXXX
1	6	50.4833	XXXX
3	5	57.68	XXX
10	5	58.074	XXX
5	6	59.8	XXX
7	5	65.26	XXX
6	5	74.52	XX
13	5	87.5	XX
2	5	124.98	XX
4	5	145.34	X



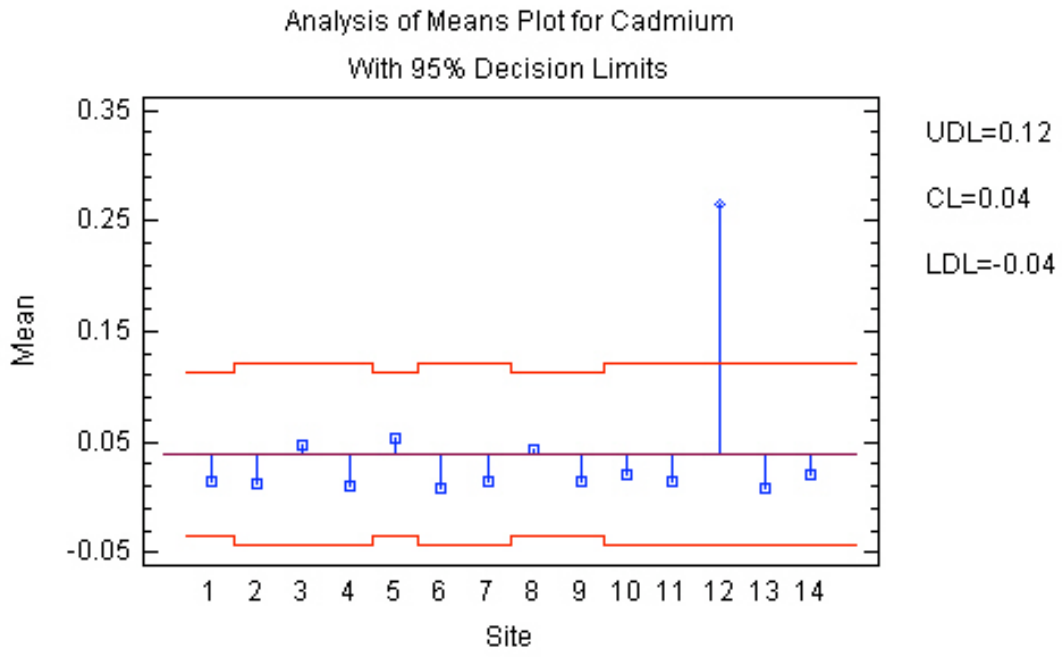
ANOVA Table for Cadmium by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	0.289505	13	0.0222696	5.62	0.0000
Within groups	0.23775	60	0.0039625		
Total (Corr.)	0.527255	73			

Multiple Range Tests for Cadmium by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
13	5	0.0076	X
6	5	0.0084	X
4	5	0.0106	X
2	5	0.0126	X
1	6	0.0135	X
11	5	0.0148	X
9	6	0.015	X
7	5	0.0152	X
10	5	0.0198	X
14	5	0.0206	X
8	6	0.0438333	X
3	5	0.0468	X
5	6	0.0535	X
12	5	0.2644	X



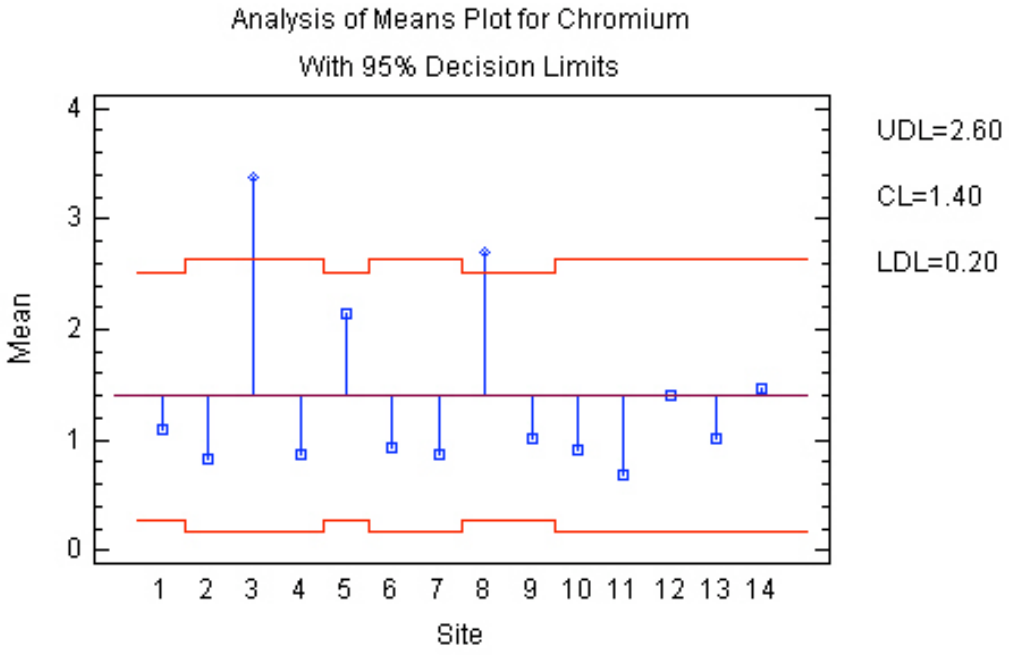
ANOVA Table for Chromium by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	44.5972	13	3.43055	3.82	0.0002
Within groups	53.8899	60	0.898166		
Total (Corr.)	98.4871	73			

Multiple Range Tests for Chromium by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
11	5	0.676	X
2	5	0.818	X
7	5	0.872	X
4	5	0.872	X
10	5	0.92	X
6	5	0.924	X
13	5	1.006	XX
9	6	1.01833	X
1	6	1.09167	XX
12	5	1.406	XX
14	5	1.458	XX
5	6	2.13833	XX
8	6	2.7	XX
3	5	3.378	X



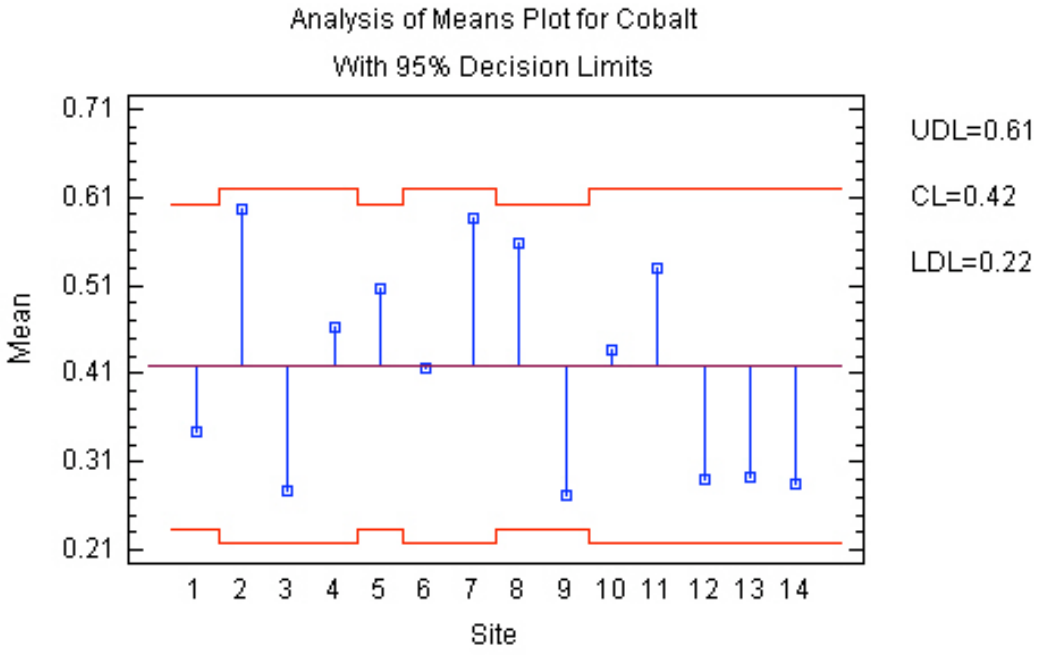
ANOVA Table for Cobalt by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	1.04807	13	0.080621	3.39	0.0006
Within groups	1.42863	60	0.0238104		
Total (Corr.)	2.4767	73			

Multiple Range Tests for Cobalt by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
9	6	0.272983	X
3	5	0.2772	XX
14	5	0.2844	XX
12	5	0.2898	XX
13	5	0.2916	XX
1	6	0.343167	XXX
6	5	0.4174	XXX
10	5	0.4372	XXX
4	5	0.4618	XXX
5	6	0.5065	XX
11	5	0.53	XX
8	6	0.557333	X
7	5	0.5862	X
2	5	0.5962	X



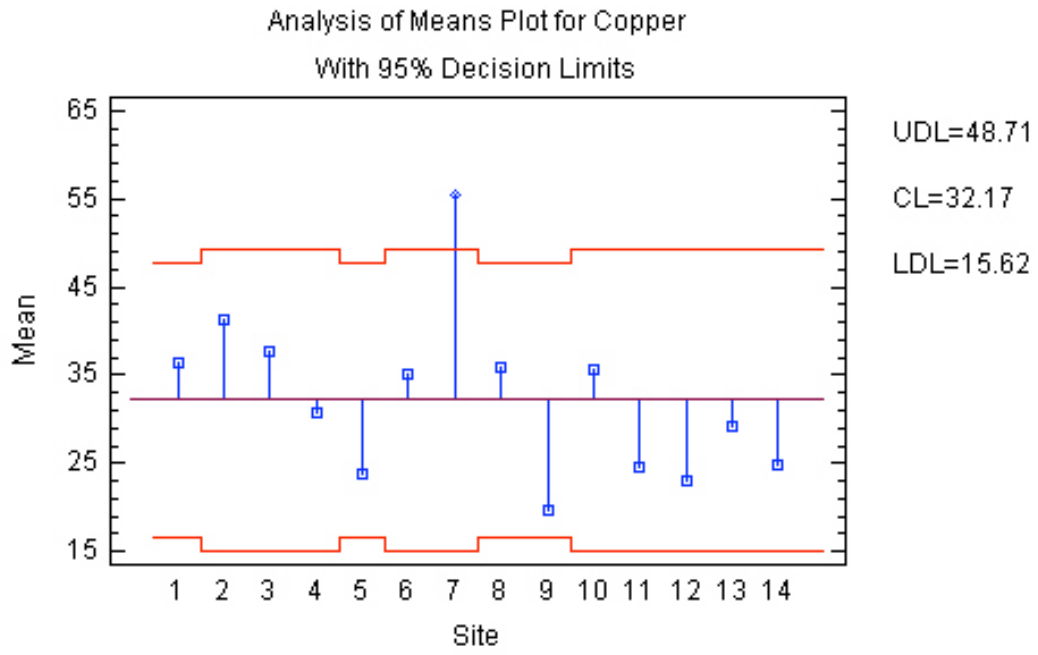
ANOVA Table for Copper by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	5947.27	13	457.483	2.68	0.0050
Within groups	10251.0	60	170.85		
Total (Corr.)	16198.2	73			

Multiple Range Tests for Copper by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
9	6	19.65	X
12	5	23.1	XX
5	6	23.8	XX
11	5	24.5	XX
14	5	24.74	XXX
13	5	29.2	XXX
4	5	30.7	XXX
6	5	35.16	XXX
10	5	35.54	XX
8	6	35.8333	XX
1	6	36.4167	XX
3	5	37.7	XX
2	5	41.16	XX
7	5	55.42	X



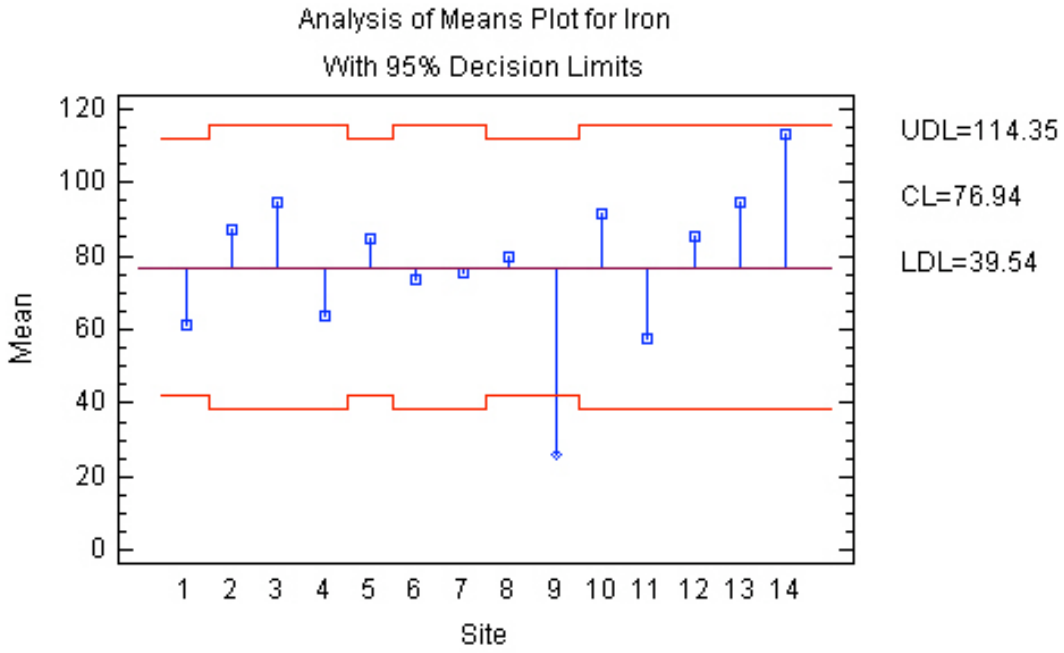
ANOVA Table for Iron by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	31840.5	13	2449.27	2.80	0.0034
Within groups	52392.3	60	873.204		
Total (Corr.)	84232.7	73			

Multiple Range Tests for Iron by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
9	6	26.015	X
11	5	57.42	XX
1	6	61.5333	X
4	5	63.6	X
6	5	73.82	X
7	5	75.54	X
8	6	79.5167	XX
5	6	84.7667	XX
12	5	85.36	XX
2	5	87.1	XX
10	5	91.28	XX
13	5	94.42	XX
3	5	94.8	XX
14	5	113.2	X



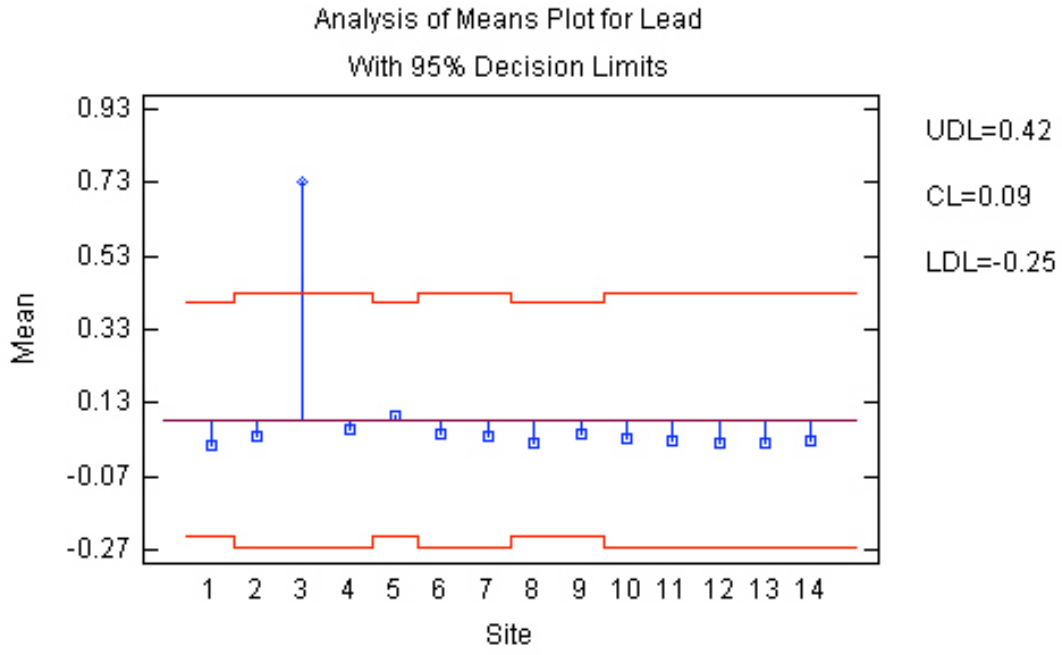
ANOVA Table for Lead by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	2.28889	13	0.176069	2.50	0.0085
Within groups	4.2335	60	0.0705583		
Total (Corr.)	6.52239	73			

Multiple Range Tests for Lead by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
1	6	0.0166667	X
8	6	0.0191667	X
13	5	0.02	X
12	5	0.022	X
11	5	0.0258	X
14	5	0.03	X
10	5	0.0318	X
7	5	0.038	X
2	5	0.0412	X
6	5	0.0478	X
9	6	0.0478333	X
4	5	0.056	X
5	6	0.0983333	X
3	5	0.734	X



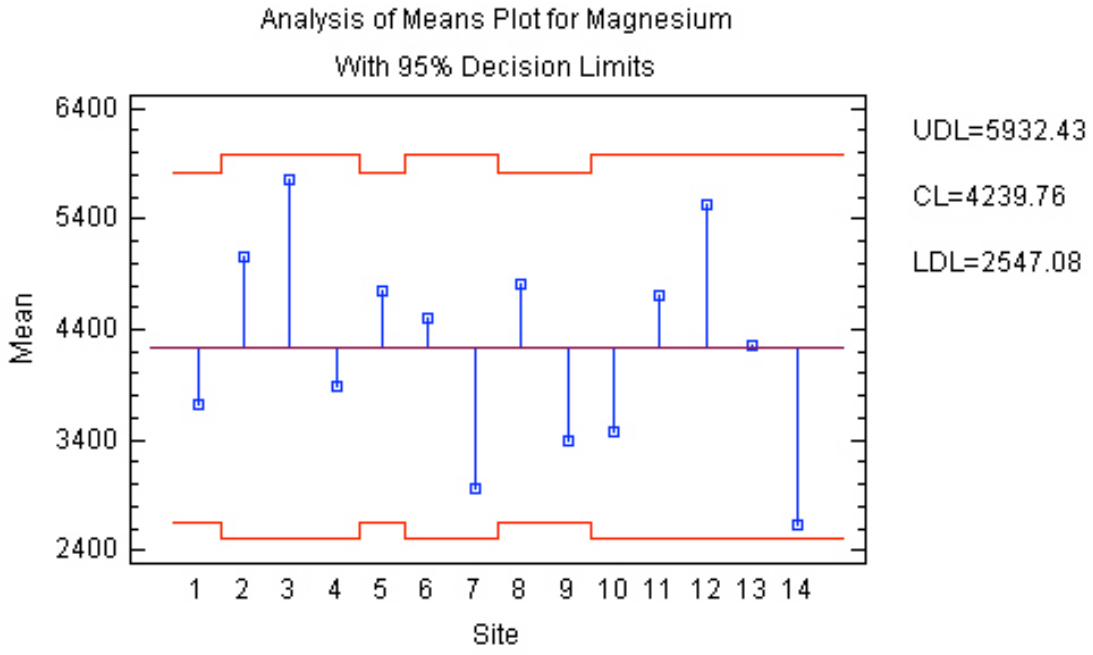
ANOVA Table for Magnesium by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	5.86926E7	13	4.51481E6	2.52	0.0078
Within groups	1.07294E8	60	1.78823E6		
Total (Corr.)	1.65986E8	73			

Multiple Range Tests for Magnesium by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
14	5	2622.0	X
7	5	2950.0	XX
9	6	3401.67	XXX
10	5	3476.4	XXXX
1	6	3725.0	XXXX
4	5	3876.0	XXXXX
13	5	4266.0	XXXXXX
6	5	4500.0	XXXXX
11	5	4702.0	XXXX
5	6	4760.0	XXXX
8	6	4803.33	XXXX
2	5	5054.0	XXX
12	5	5522.0	XX
3	5	5752.0	X



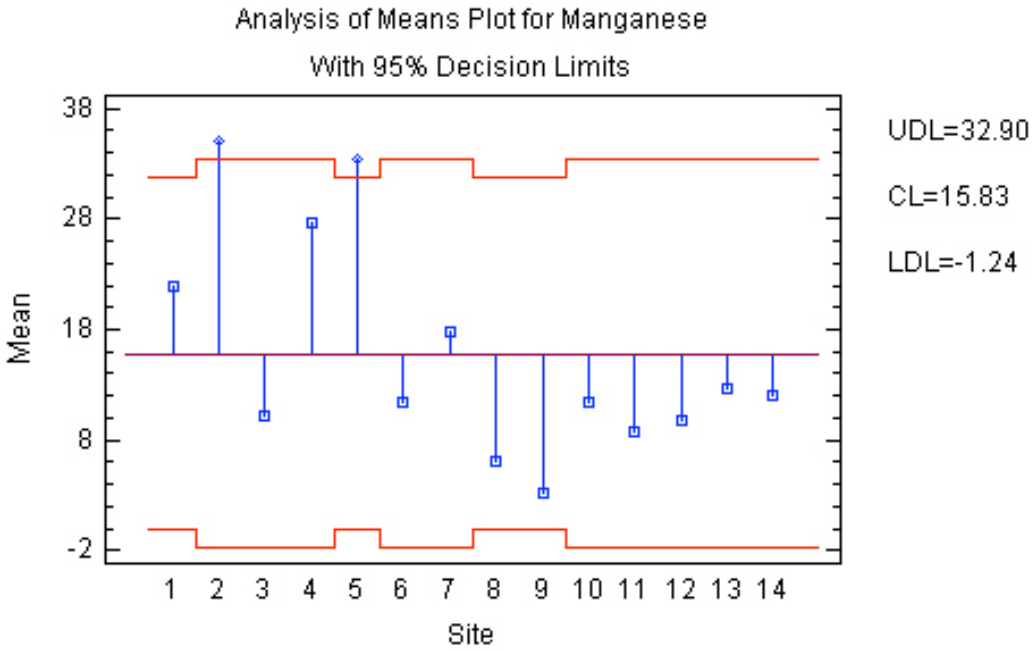
ANOVA Table for Manganese by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	7072.96	13	544.074	2.99	0.0020
Within groups	10912.8	60	181.88		
Total (Corr.)	17985.8	73			

Multiple Range Tests for Manganese by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
9	6	3.25667	X
8	6	5.97167	X
11	5	8.704	XX
12	5	9.818	XX
3	5	10.202	XX
10	5	11.514	XXX
6	5	11.516	XXX
14	5	11.932	XXX
13	5	12.666	XXX
7	5	17.82	XXXX
1	6	21.85	XXXX
4	5	27.74	XXX
5	6	33.345	XX
2	5	35.06	X



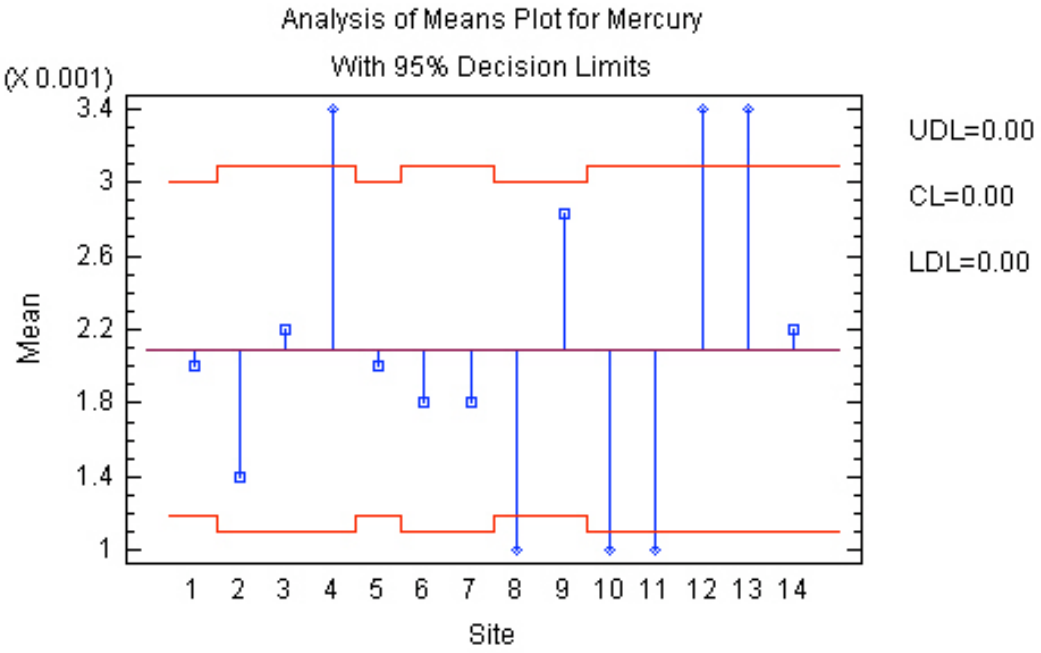
ANOVA Table for Mercury by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	0.0000515045	13	0.00000396188	6.82	0.0000
Within groups	0.0000348333	60	5.80556E-7		
Total (Corr.)	0.0000863378	73			

Multiple Range Tests for Mercury by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
11	5	0.001	X
10	5	0.001	X
8	6	0.001	X
2	5	0.0014	XX
7	5	0.0018	XX
6	5	0.0018	XX
5	6	0.002	XX
1	6	0.002	XX
14	5	0.0022	XX
3	5	0.0022	XX
9	6	0.00283333	XX
13	5	0.0034	X
12	5	0.0034	X
4	5	0.0034	X



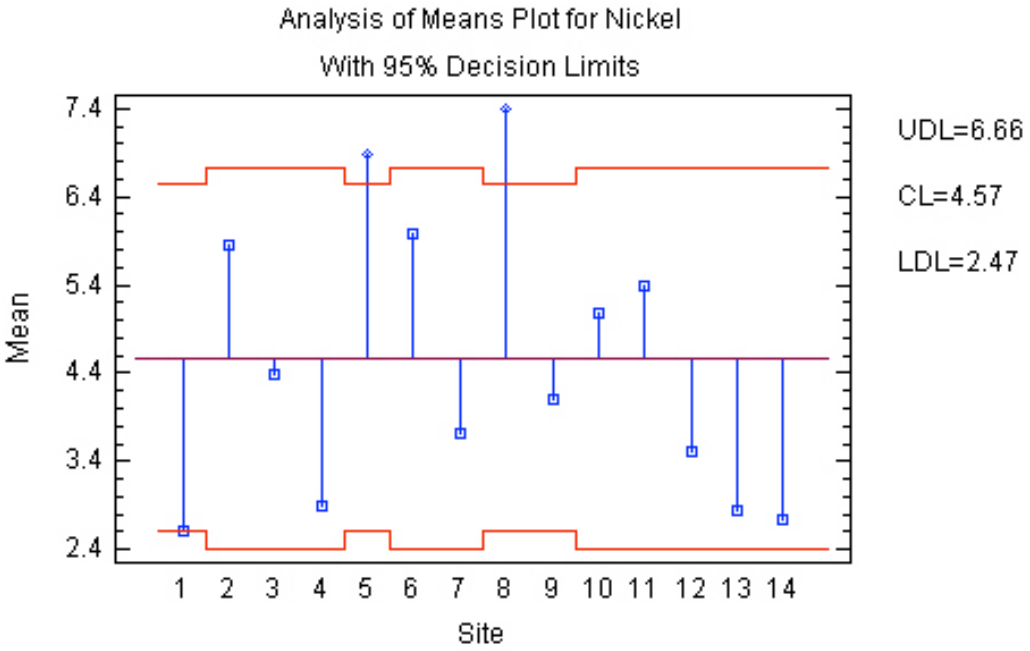
ANOVA Table for Nickel by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	182.049	13	14.0038	5.11	0.0000
Within groups	164.54	60	2.74233		
Total (Corr.)	346.589	73			

Multiple Range Tests for Nickel by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
1	6	2.61	X
14	5	2.74	X
13	5	2.846	X
4	5	2.884	X
12	5	3.524	XX
7	5	3.712	XX
9	6	4.10833	XXX
3	5	4.382	XXX
10	5	5.088	XXX
11	5	5.398	XXXX
2	5	5.84	XXX
6	5	5.986	XXX
5	6	6.87333	XX
8	6	7.395	X



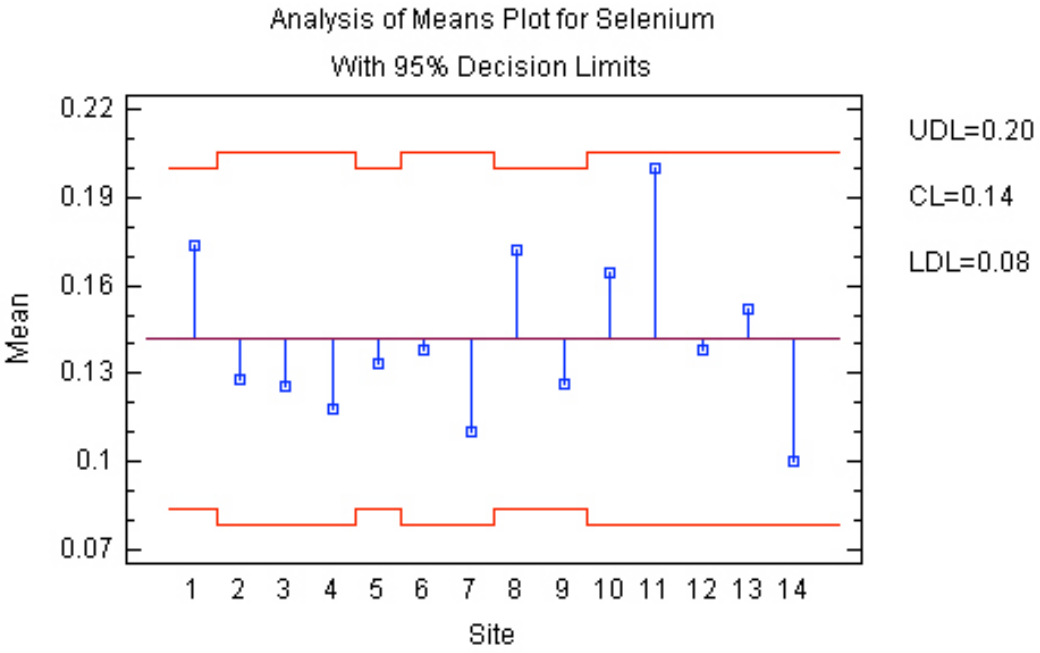
ANOVA Table for Selenium by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	0.0520118	13	0.00400091	1.69	0.0857
Within groups	0.141723	60	0.00236206		
Total (Corr.)	0.193735	73			

Multiple Range Tests for Selenium by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
14	5	0.1	X
7	5	0.11	XX
4	5	0.118	XXX
3	5	0.126	XXX
9	6	0.126667	XXX
2	5	0.128	XXX
5	6	0.133333	XXX
6	5	0.138	XXX
12	5	0.138	XXX
13	5	0.152	XXXX
10	5	0.164	XXX
8	6	0.171667	XX
1	6	0.173333	XX
11	5	0.2	X



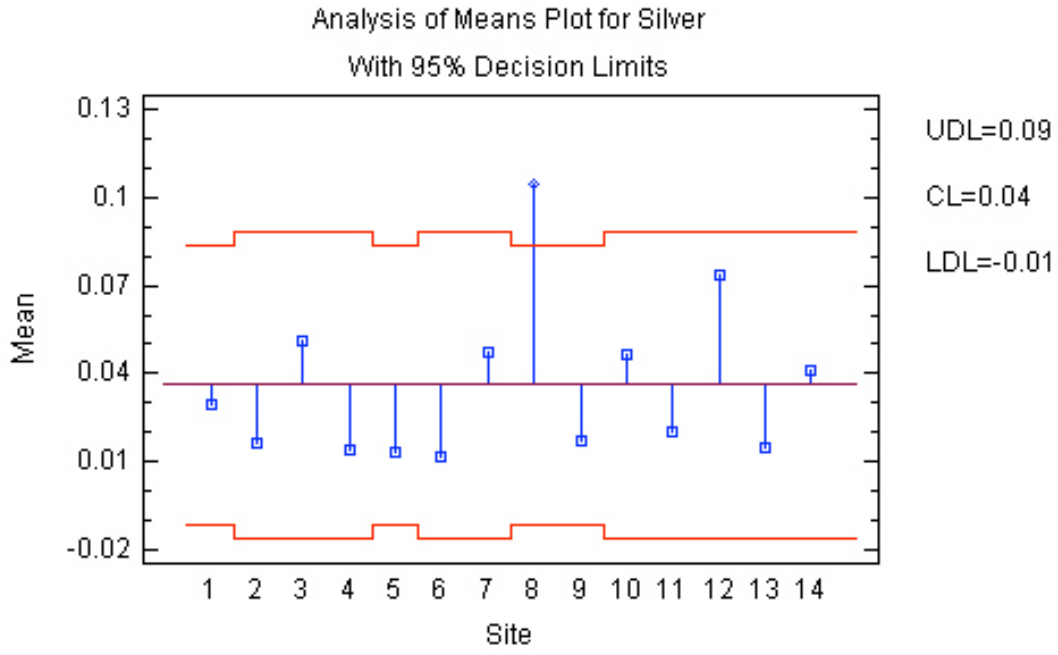
ANOVA Table for Silver by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	0.0539597	13	0.00415075	2.57	0.0068
Within groups	0.0968614	60	0.00161436		
Total (Corr.)	0.150821	73			

Multiple Range Tests for Silver by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
6	5	0.01154	X
5	6	0.0133333	X
4	5	0.0142	X
13	5	0.015	X
2	5	0.01622	X
9	6	0.0173833	X
11	5	0.02058	X
1	6	0.0295	XX
14	5	0.0412	XX
10	5	0.04674	XX
7	5	0.0472	XX
3	5	0.0508	XX
12	5	0.0738	XX
8	6	0.104617	X



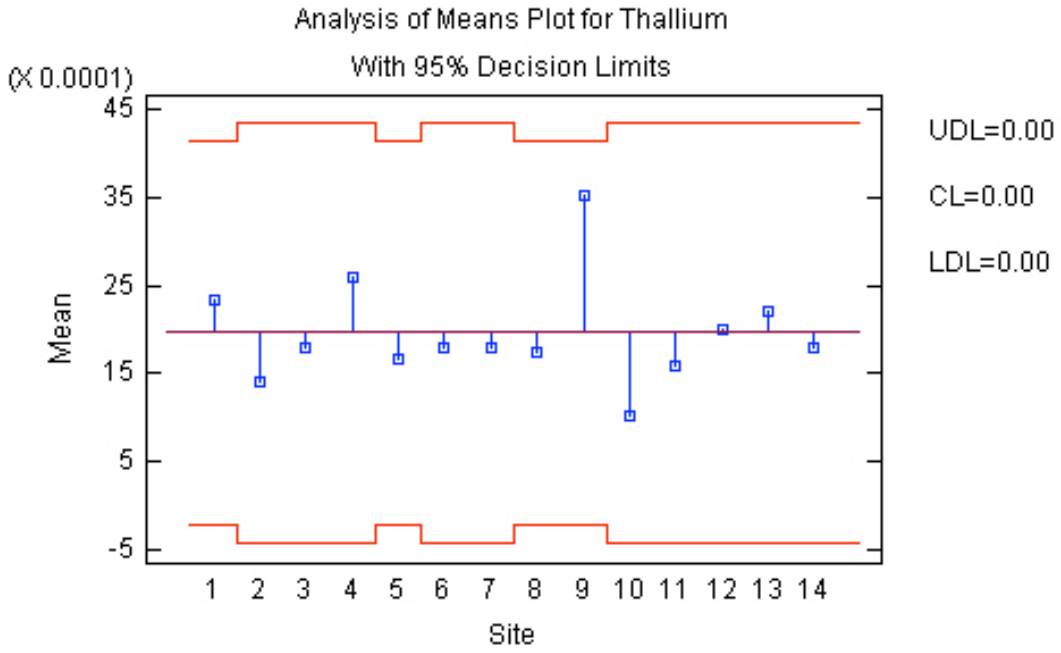
ANOVA Table for Thallium by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	0.0000256498	13	0.00000197306	0.59	0.8525
Within groups	0.000200632	60	0.00000334387		
Total (Corr.)	0.000226282	73			

Multiple Range Tests for Thallium by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
10	5	0.00102	X
2	5	0.00142	XX
11	5	0.00158	XX
5	6	0.00166667	XX
8	6	0.00173333	XX
7	5	0.0018	XX
3	5	0.0018	XX
14	5	0.0018	XX
6	5	0.0018	XX
12	5	0.002	XX
13	5	0.0022	XX
1	6	0.00233333	XX
4	5	0.0026	XX
9	6	0.00351667	X



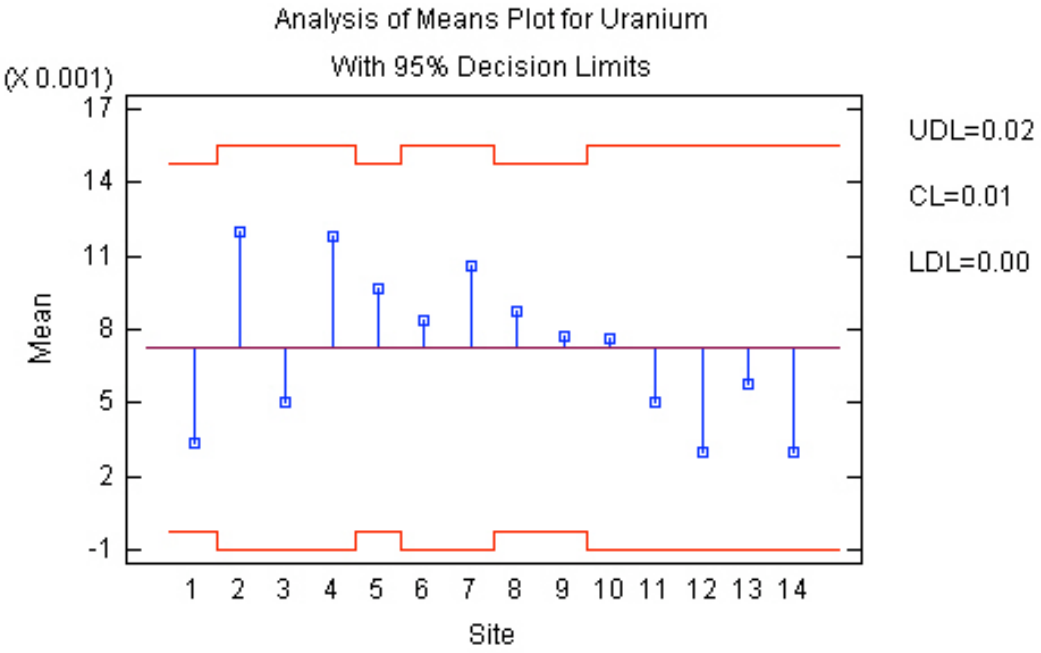
ANOVA Table for Uranium by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	0.000659384	13	0.0000507218	1.27	0.2575
Within groups	0.00240013	60	0.0000400021		
Total (Corr.)	0.00305951	73			

Multiple Range Tests for Uranium by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
14	5	0.003	X
12	5	0.003	X
1	6	0.00333333	X
3	5	0.005	XX
11	5	0.00508	XX
13	5	0.0058	XX
10	5	0.00766	XX
9	6	0.00775	XX
6	5	0.0084	XX
8	6	0.00876667	XX
5	6	0.00966667	XX
7	5	0.0106	XX
4	5	0.0118	X
2	5	0.01194	X



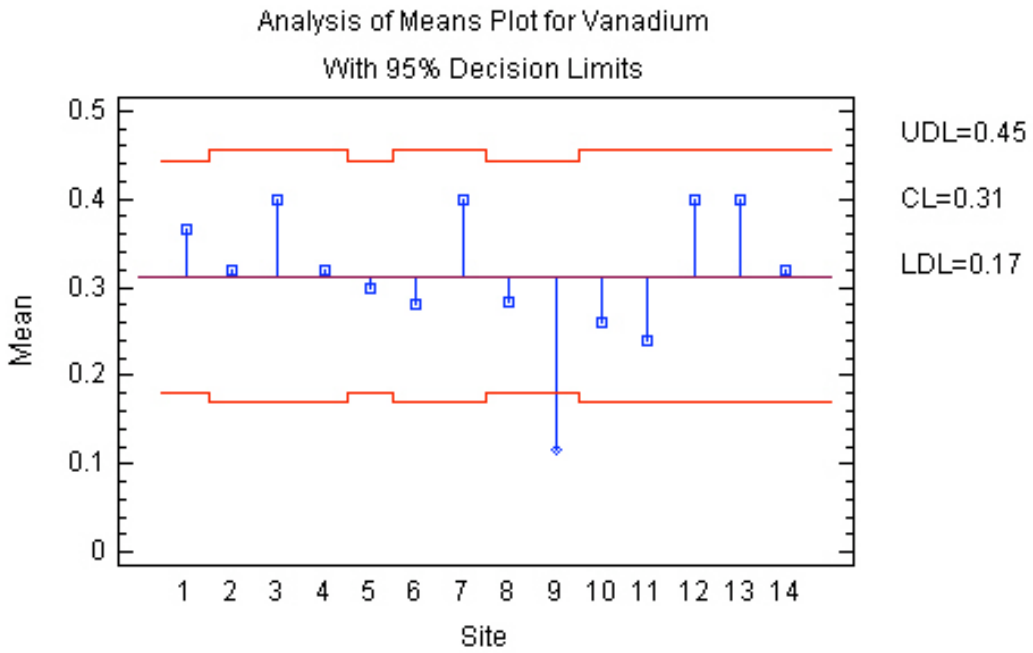
ANOVA Table for Vanadium by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	0.453054	13	0.0348503	2.88	0.0027
Within groups	0.726	60	0.0121		
Total (Corr.)	1.17905	73			

Multiple Range Tests for Vanadium by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
9	6	0.116667	X
11	5	0.24	XX
10	5	0.26	X
6	5	0.28	XX
8	6	0.283333	XX
5	6	0.3	XX
4	5	0.32	XX
2	5	0.32	XX
14	5	0.32	XX
1	6	0.366667	XX
7	5	0.4	X
13	5	0.4	X
12	5	0.4	X
3	5	0.4	X



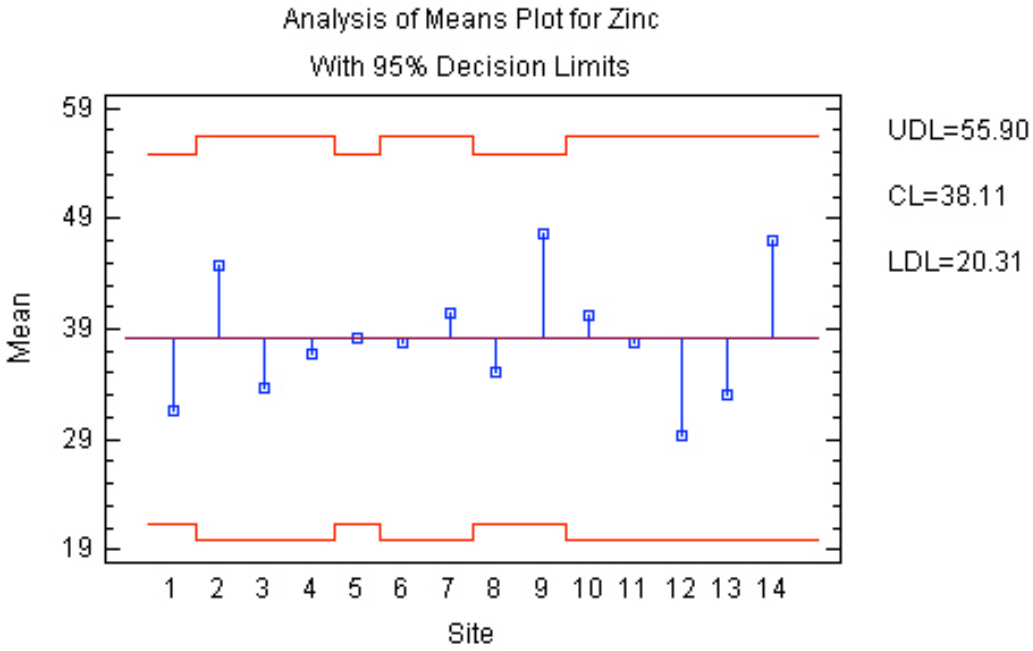
ANOVA Table for Zinc by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	2163.34	13	166.411	0.84	0.6150
Within groups	11852.5	60	197.541		
Total (Corr.)	14015.8	73			

Multiple Range Tests for Zinc by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
12	5	29.36	X
1	6	31.5	XX
13	5	33.08	XX
3	5	33.66	XX
8	6	35.05	XX
4	5	36.84	XX
6	5	37.8	XX
11	5	37.82	XX
5	6	38.1333	XX
10	5	40.14	XX
7	5	40.5	XX
2	5	44.84	XX
14	5	47.1	XX
9	6	47.6667	X



ANOVA Table for tDDT by Site

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Between groups	56202.7	13	4323.28	4.03	0.0001
Within groups	64369.2	60	1072.82		
Total (Corr.)	120572.	73			

Multiple Range Tests for tDDT by Site

Method: 95.0 percent LSD

Site	*Count*	*Mean*	*Homogeneous Groups*
13	5	0.0	X
14	5	0.15	X
5	6	0.166667	X
2	5	0.21	X
6	5	0.336	X
4	5	0.358	X
1	6	0.916667	X
8	6	1.77333	X
12	5	1.782	X
7	5	3.632	X
11	5	6.102	X
10	5	24.806	X
9	6	75.9417	X
3	5	82.106	X